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APPLICATION NUMBER: ***60/537,243***
FILING DATE: ***January 14, 2004***
RELATED PCT APPLICATION NUMBER: ***PCT/US05/01381***

UNITED STATES PATENT AND TRADEMARK OFFICE
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Under Secretary of Commerce
for Intellectual Property
and Director of the United States
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PROVISIONAL APPLICATION COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION under 37 CFR 1.53(b)(2).

Docket Number: TIMK 8546P2 US
Express Mail No.: EV 383195075 US

INVENTOR(s)/APPLICANT(s)

LAST NAME	FIRST NAME	MIDDLE INITIAL	RESIDENCE (CITY AND EITHER STATE OR FOREIGN COUNTRY
Ai	Xiaolan		Massillon, Ohio

TITLE OF THE INVENTION (280 characters max)

AN ELECTRO-MECHANICAL GEAR SELECTOR

CORRESPONDENCE ADDRESS

CUSTOMER NUMBER 001688

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ENCLOSED APPLICATION PARTS (check all that apply)

☒ Specification	Number of pages [6]	☐ Claiming Small Entity Status
☒ Drawings	Number of sheets [13]	☐ Other (specify)
☒ Claims	Number of pages [1]	

METHOD OF PAYMENT

A check or money order in the amount of:

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The Commissioner is hereby authorized to charge any additional fees or credit overpayment under 37 CFR 1.16 and 1.17 which may be required by this paper to Deposit Account 162201. *Duplicate copies of this sheet are enclosed.*

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☒ No
☐ Yes, the name of the Government Agency and the Government Contract Number are:

Respectfully submitted,

Edward A. Boeschenstein   Date: 1-14-04

Edward A. Boeschenstein, Reg. No. 22,986

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EXPRESS MAIL FILING CERTIFICATE

RE: U.S. Provisional Patent Application
TITLE: AN ELECTRO-MECHANICAL GEAR SELECTOR
INVENTOR: Xiaolan Ai

I hereby certify that this U.S. Provisional Patent Application is being deposited with the United States Postal Service utilizing the "Express Mail Post Office to Addressee" service addressed to Mailstop Provisional Patent Application, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-3615 on January 14, 2004.

Edward A. Boeschenstein

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1-14-04

Date of Signature

Express Mail No.: EV 383195075 US

AN ELECTRO-MECHANICAL GEAR SELECTOR

Xiaolan Ai

BACKROUND OF THE INVENTION

Synchro-mesh devices are commonly used in vehicle gear boxes to simplify the operation of gear change so that this can be done by unskilled drivers without the occurrence of clashes and consequent damage. These devices usually incorporate a positive engagement clutch such as a dog clutch and a friction clutch such as a cone clutch. These clutches were designed primarily for toque-interrupt shifting where the power was momentarily cut off during gear change. The gear and shaft were first brought to the same speed by the friction clutch and then a positive engagement was made through actuating the positive engagement clutch. The synchro-mesh devices can be applied to sliding-mesh gear boxes but almost always used with constant-mesh boxes. In spite their popularity, the synchro-mesh are devices are not always trouble free. There are times when the jaws or teeth of one member of the positive engagement clutch are not aligned up well with the groove on the mating member and the clutch will not engage. In addition, synchro-mesh devices are prone to wear and are not suitable for power-shifting.

With the introduction of automated manual transmissions (AMT), the desire for trouble free engagement and power-shifting becomes increasingly strong. It almost becomes a necessity rather than a luxury. The present invention provides a compact gear selector, capable of providing positive and trouble free engagement and power-shifting operation.

The present invention relates to a positive engagement clutch in general and to an electromagnetic actuated gear selector for automated manual transmissions in particular.

DESCRIPTION OF THE INVENTION

Refer now to Figures 1 and 2, a preferred embodiment comprising a gear-clutch assembly 1 and an electromagnetic actuator assembly 2. The gear-clutch assembly 1 further comprises a gear 10, a needle bearing 11, a hub 12, a hub cover 13, a spring 14, an internally splined ramp ring 15, an externally splined ramp ring 16, a set of keys 17 and a set of coil spring 18. The electromagnetic actuator assembly 2 comprises a base 20 ring, an electric coil 21, a case 22, a plunge ring 23, a sleeve 24, a case holder 25, a bearing holder 26 and a ball bearing 27.

The gear 10 is has two inner cylindrical surfaces 10a and 10b (Figure 3). A plurality of axial grooves 10c was cut out on cylindrical surface 10a. The gear 10 supported through the needle bearing 11 on hub 12.

Hub 12 (see Figure 4) has outer cylindrical surfaces 12c, 12d and 12e and inner cylindrical surfaces 12a 12b and 12g. A plurality of one-side-open grooves 12k was cut out of external surfaces 12d and 12e. A plurality of spline grooves 12h was cut out of inner surface 12b. The spline grooves 12h extend roughly half width of the surface 12b. Gear 10 is riding on surface 12c of the hub via needle bearing 11. The inner surface 12a of hub 12 rides on a mating surface of a supporting shaft 30 (not shown).

Hub cover 13 (see Figure 5) has a cover plate 13a and a spindle 13b. The plate 13a is mounted to the end face 12j of the hub 12. Hub cover 13 also has an inner cylindrical surface 13c that rides on the supporting shaft 30 (no shown).

Key 17 (Figure 6) is made to have two top surfaces 17a and 17b and a ramp surface 17c connecting the two top surfaces. Two recesses 17 d and 17e are cut out from the bottom surface 17f. The key is assembled in one of the open-end grooves 12k of the hub12. The key 16 is fully confined both in circumferential and axial directions by groove 12k and by the hub plate 13a of hub cover 13. There is a key for each open-end groove 12k. A coil spring 18 is hosted in each recess of the key 16. They are two coil springs 18 for each key 17 that urge the key to move outward away from its retracted position at the bottom of the grooves 12k (see Figures 7 and 8).

The internally splined ramp ring 15, externally splined ramp ring 16 and the spring 14 are assembled axially inside of hub 12 and surrounded by the inner cylindrical surface 12b (see Figure 8). The internally splined ramp 15 has a flat end face 15a and curved end faces 15b where three sets of bi-directional helical ramping surfaces are formed (Figures 9(a) and 9(b)). The flat end face 15a is placed against the annular surface 12i of hub 12. The internal spline 15c is fitted over a mating external spine on the supporting shaft 30 to rotationally fix the internally splined ramp ring 15 with the supporting shaft 30. The externally splined ramp ring 16 also has a flat end face 16a and curved end faces 16b similar to that of ramp ring 15. The curved end faces 16b of the externally splined ramp ring 16 is placed against the curved end faces 15b of the internally splined

ramp ring 15. Spring 14 is placed between the cover plate 13a of hub cover 13 and externally splined ramp ring 16. Spring 14 urges the externally splined ramp ring 16 axially firmly pressing it against the internally splined ramp ring 15. The external spline 16c of the externally splined ramp ring 16 is fitted into the internal spline 12h of hub 12 to rotationally fix the externally splined ramp ring 16 with the hub 12. The externally splined ramp ring 16 can move axially inside of hub 12.

As can be appreciated, the spring 14 and ramp rings 15 and 16 inside hub 12 serve as a shock load damping device. When an impact load is transmitted through hub 12 to supporting shaft 30 or vice versa, it causes the two ramp rings 15 and 16 to rotate relative to each other until spring 14 is fully compressed. The rotation stiffness is relatively low before the spring is bottomed out. This gives a good damping effect against shock loads.

The number of grooves 10c on the inner surface 10a of the gear 10 is chosen to be different from the number of keys 17 in the grooves 12k of the hub 12. The number of keys 17 is evenly divisible by the difference between the number of keys 17 and the number of grooves 10c on the inner surface 10a of the gear 10. The width of grooves 10c is wider than the width of key 17 such that at any angular alignment between the gear and hub there will always be at least one key that will align and be received by at least one groove 10c on the inner surface of the gear 10.

In the embodiment shown in Figure 1, the number of keys 17 in hub is 15 and the number of grooves on the inner surface of the gear is 12. Thus, for any given angular alignment between hub and gear there will always be (15-12=) 3

keys 17 aligning respectively with three grooves 10c and receivable by these grooves.

The engagement between hub 12 and gear 10 is controlled and actuated the electromagnetic actuator assembly 2 (Figure 10). The actuator assembly is axially fixed to and supported by the spindle 13b of the hub cover 13 through the ball bearing 27. The plunge ring 23 can move freely along the axial direction relative to the hub 12. The plunge ring 23 may rotationally be fixed to the hub 12.

The plunge ring 23 has two axial positions. When the electric coil 21 is energized, the plunge ring 23 moves toward the electric coil 21 closing the air gap between the base ring 20 and plunge ring 23. As the plunge ring 21 is moving ward the electric coil 21, it pushes the keys 17 along their ramp surfaces 17c and forces cams the keys 17 into the grooves 12k in the hub 12. The clutch is disengaged (see Figure 11).

When electric coil 21 is de-energized, the plunge ring 23 retracts back and moves away from the electric coil 21 by at least one key that is urged outward from it retracted position. In the current embodiment, when de-energized, there will always be at least three keys 17 that are urged outwardly from their retracted positions and pushed the plunge ring 23 axially away from the electric coil 21. The clutch is engaged (see Figure 12).

During engagement, if the speeds of the hub 12 and gear 10 are not synchronized, there will be an impact load exerts on shaft 30. As mentioned, the impact load is substantially reduced by spring 14 and ramp rings 15 and 16.

The embodiment shown here is to disclose the invention. It by no means restricts the scope of the invention.

CLAIMS:

1. A gear-clutch assembly organized about an axis and comprising:

A gear having grooves that open inwardly toward the axis and extend axially;

A hub located within the gear where it is capable of rotating within the gear, the hub having grooves that open outwardly away from the axis and extend axially;

keys located within the grooves of the hub and being capable of moving radially toward and away from the axis, the arrangement being such that when the keys are permitted to move away from the axis, at least one will enter one of the grooves in the gear to couple the gear and hub so that they will rotate in unison, and

an actuator for effecting radial displacement of the keys.

2. An assembly according to claim 1 and further comprising springs for urging the keys outwardly away from the axis; and wherein the actuator when energized moves the keys inwardly toward the axis.

3. An assembly according to claim 2 and further comprising means for absorbing torsional shocks.

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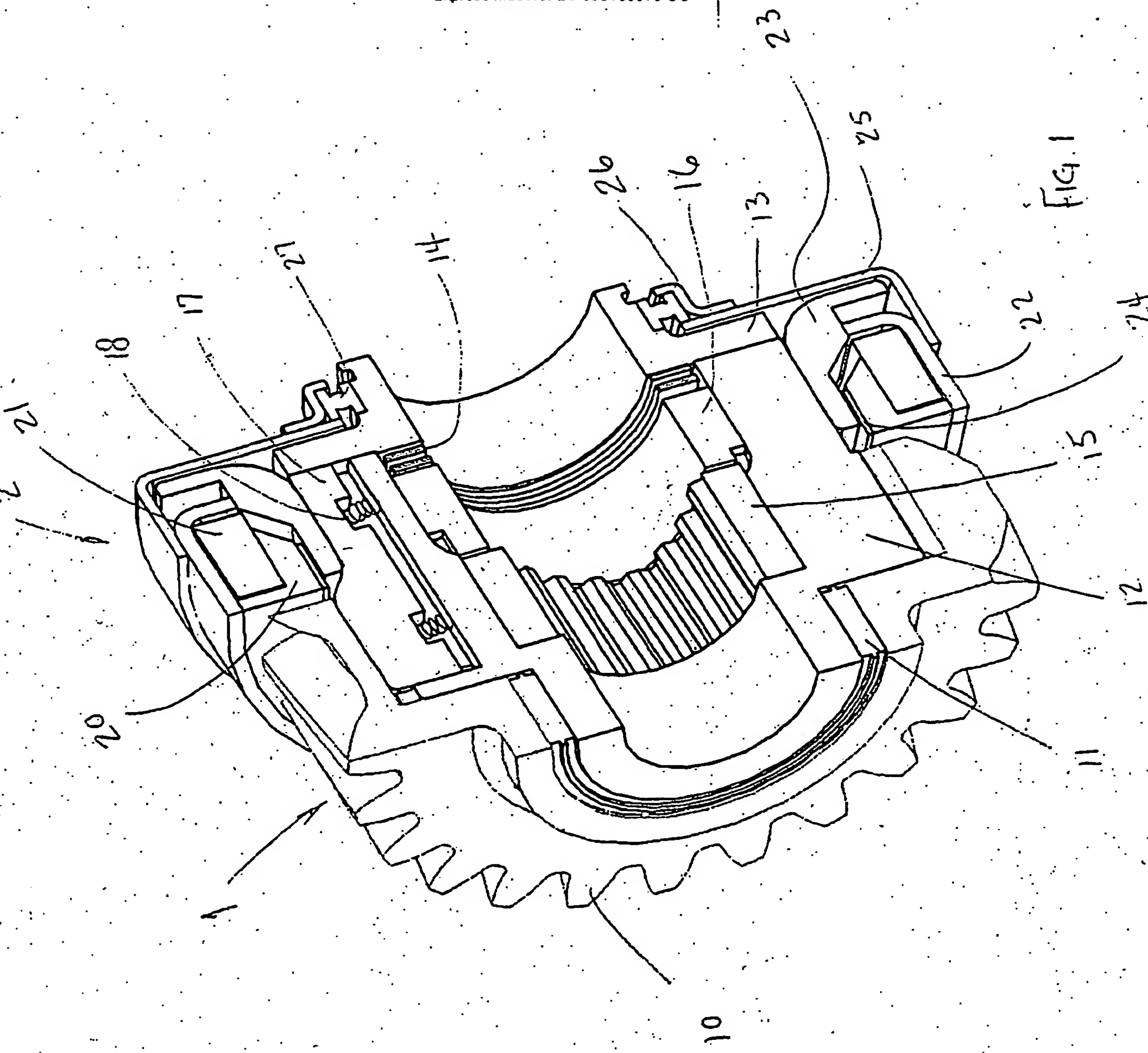
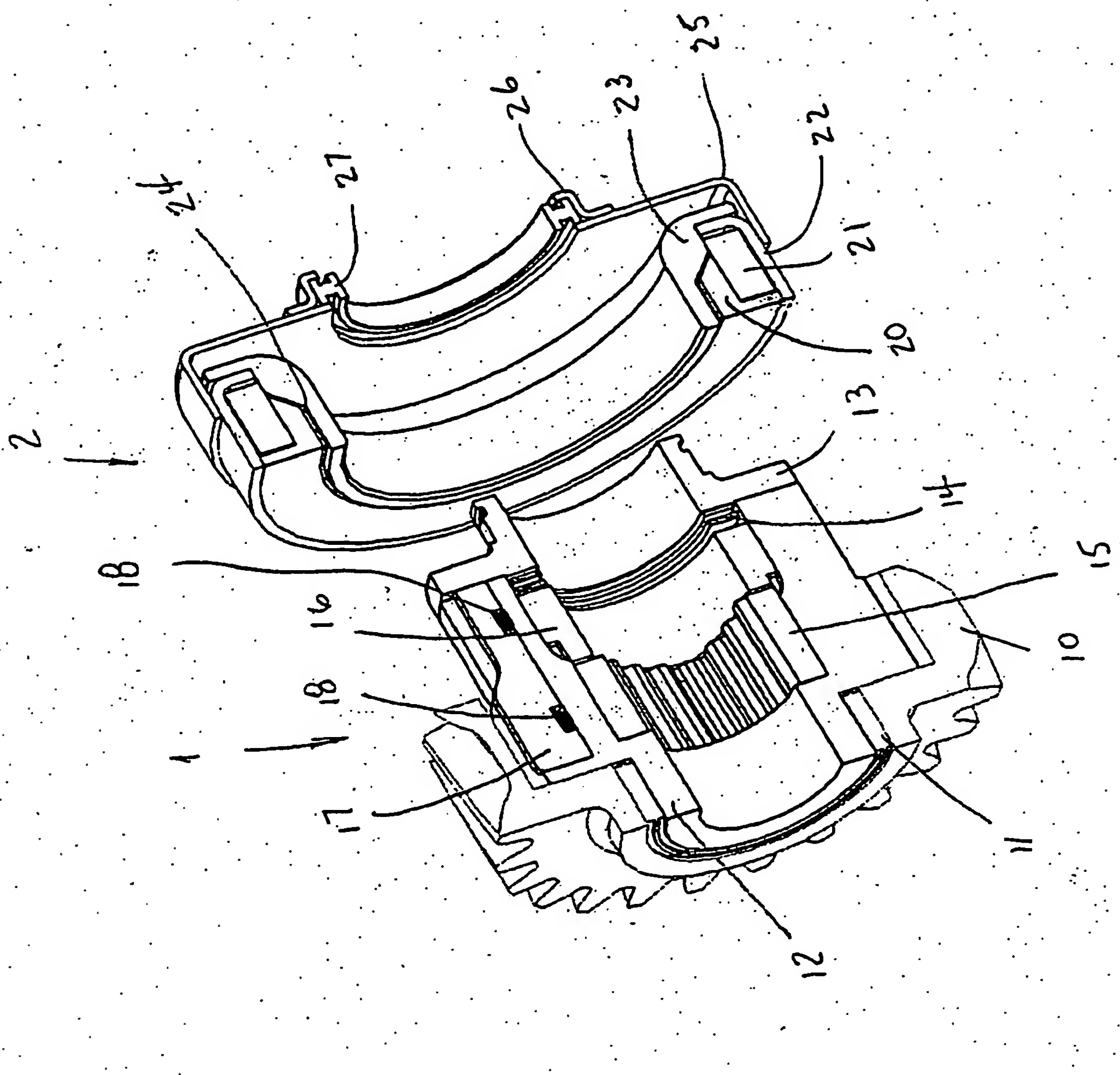


FIG. 1

FIG. 2



DN TIMK 8546P2 US Sheet 3 of 13
Inventor: Xiaolan Ai
Title: AN ELECTRO-MECHANICAL
GEAR SELECTOR
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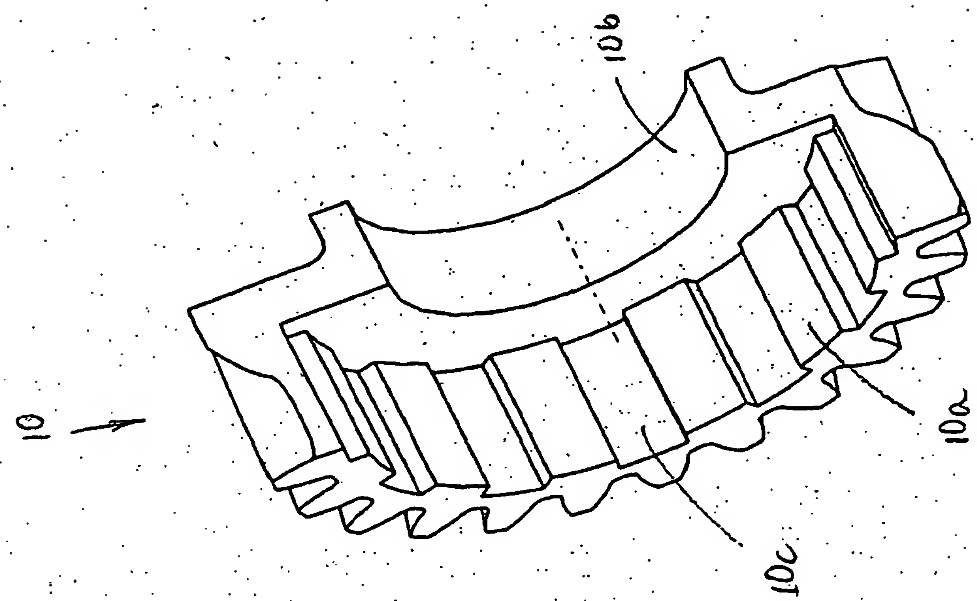

FIG. 3

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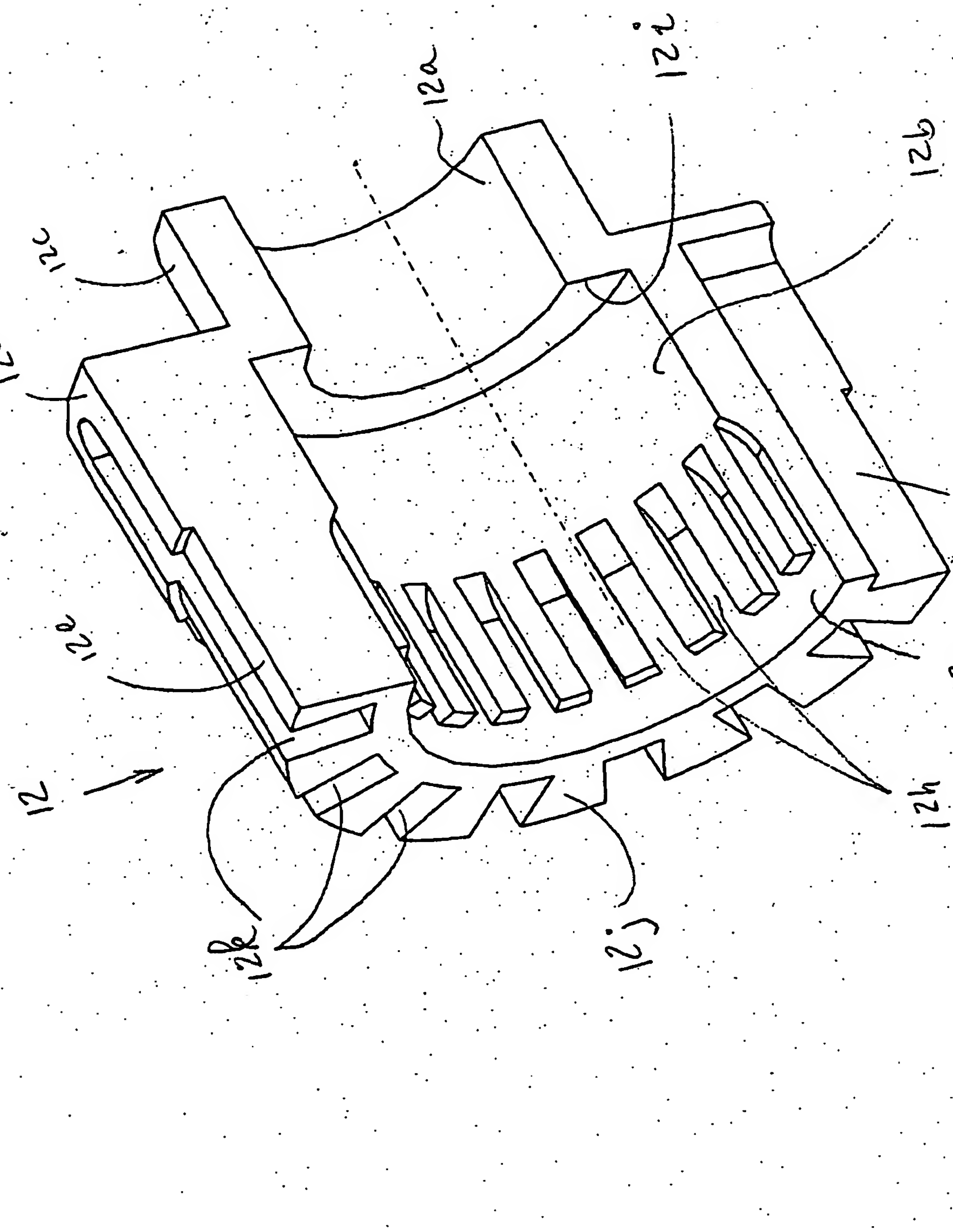
Fig. 4



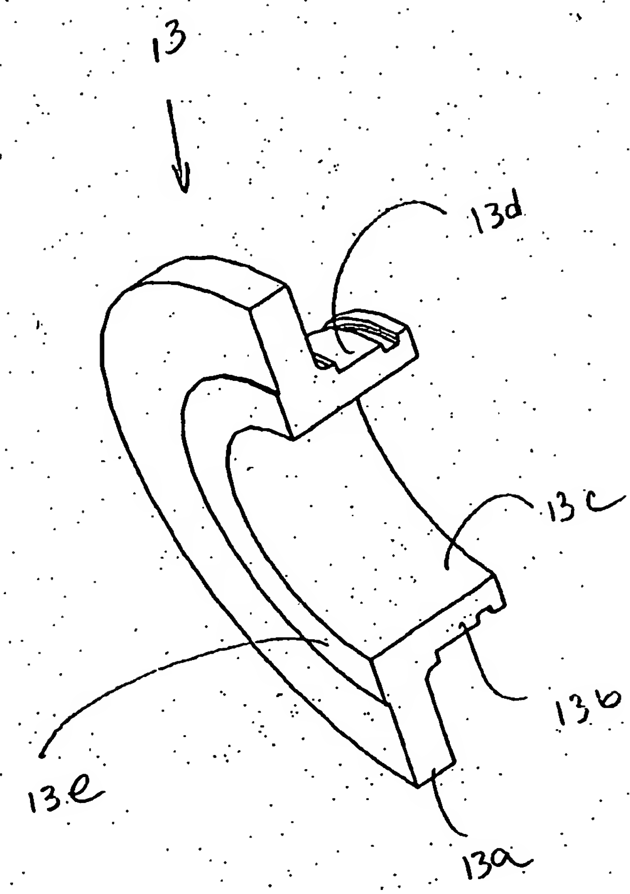


FIG. 5

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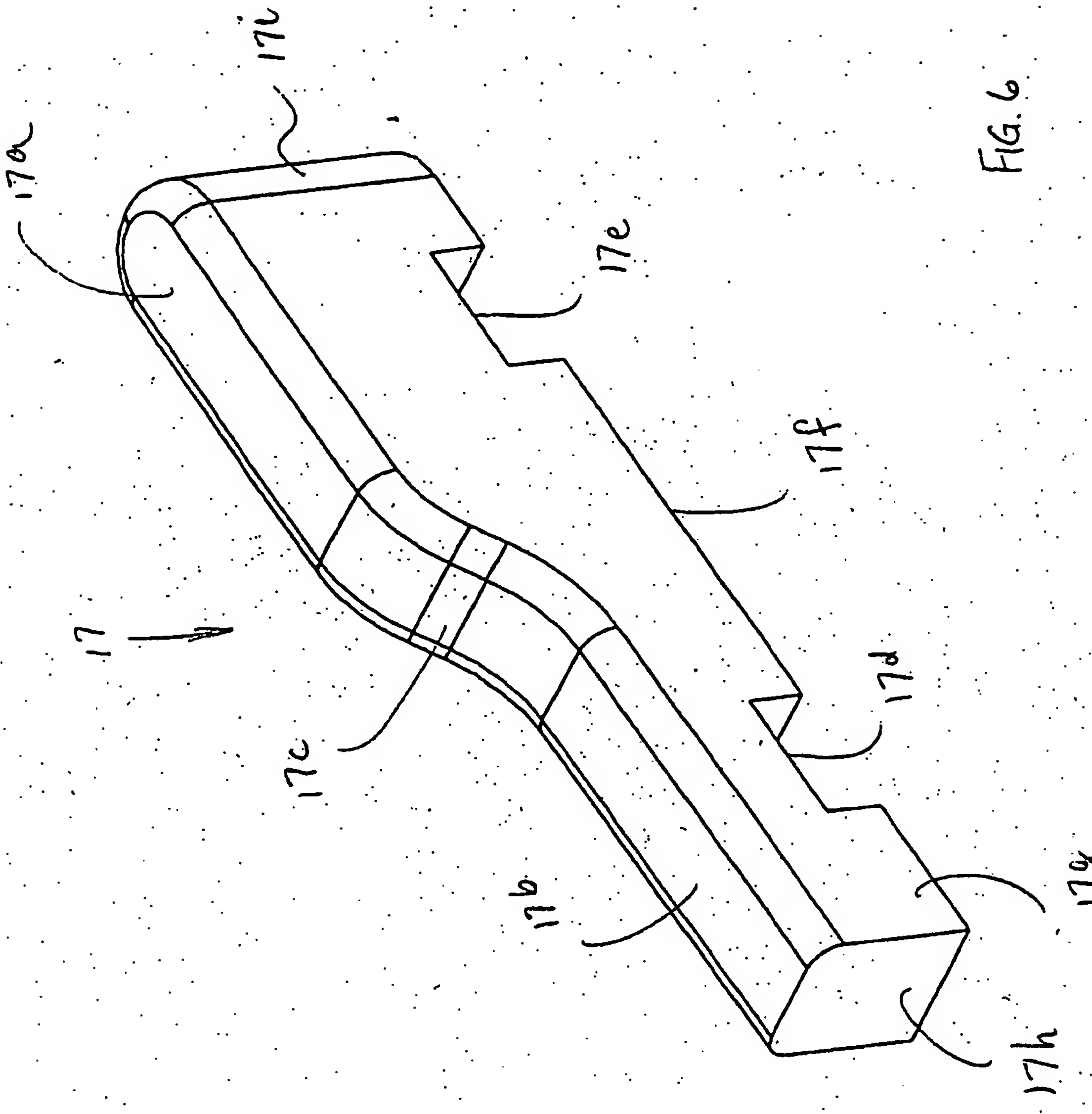

FIG. 6

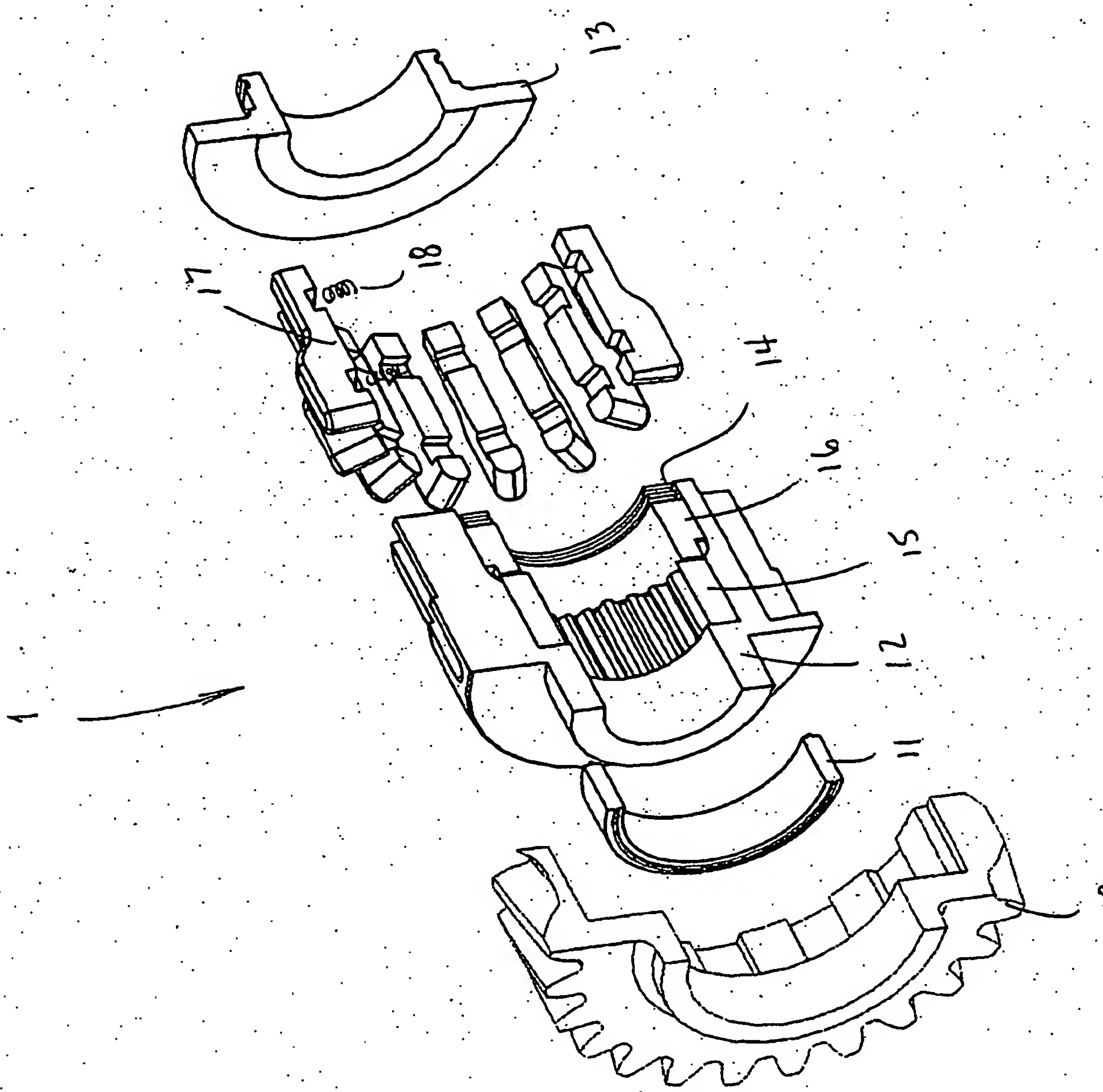

FIG 7

DN TIMK 8546P2 US Sheet 8 of 13
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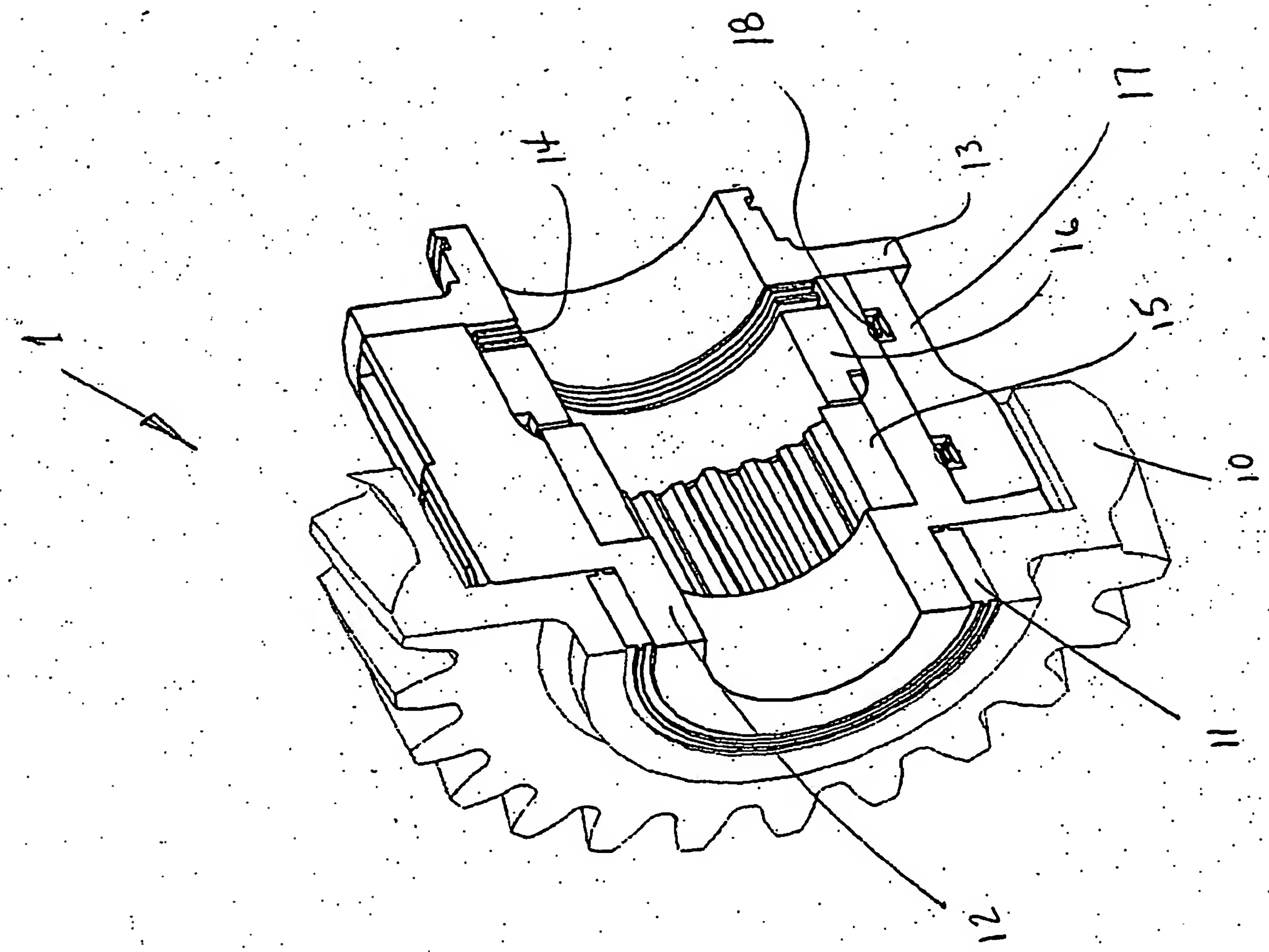

FIG. 8

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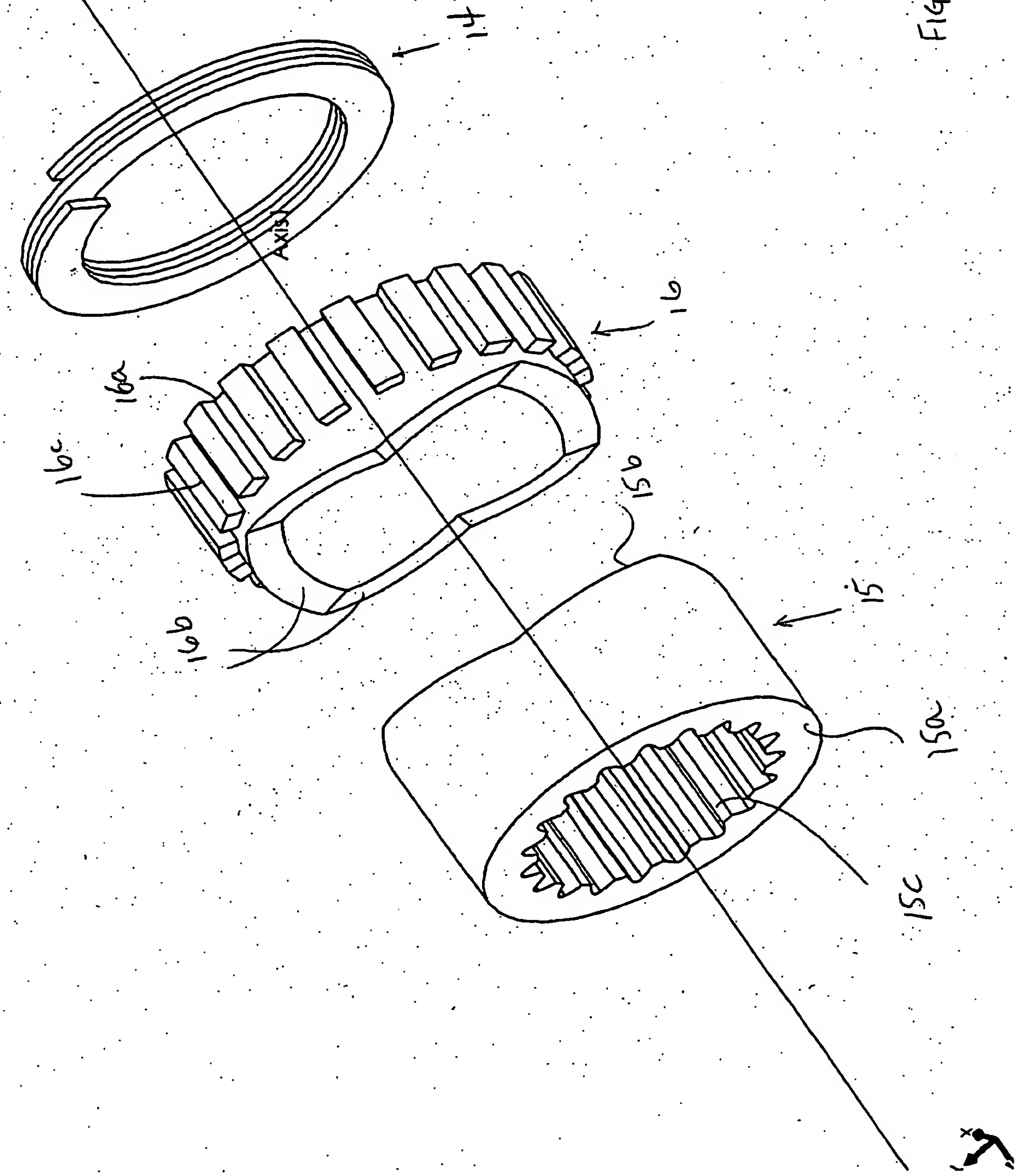
Fig 9(a)



DN TIMK 8546P2 US Sheet 10 of 13
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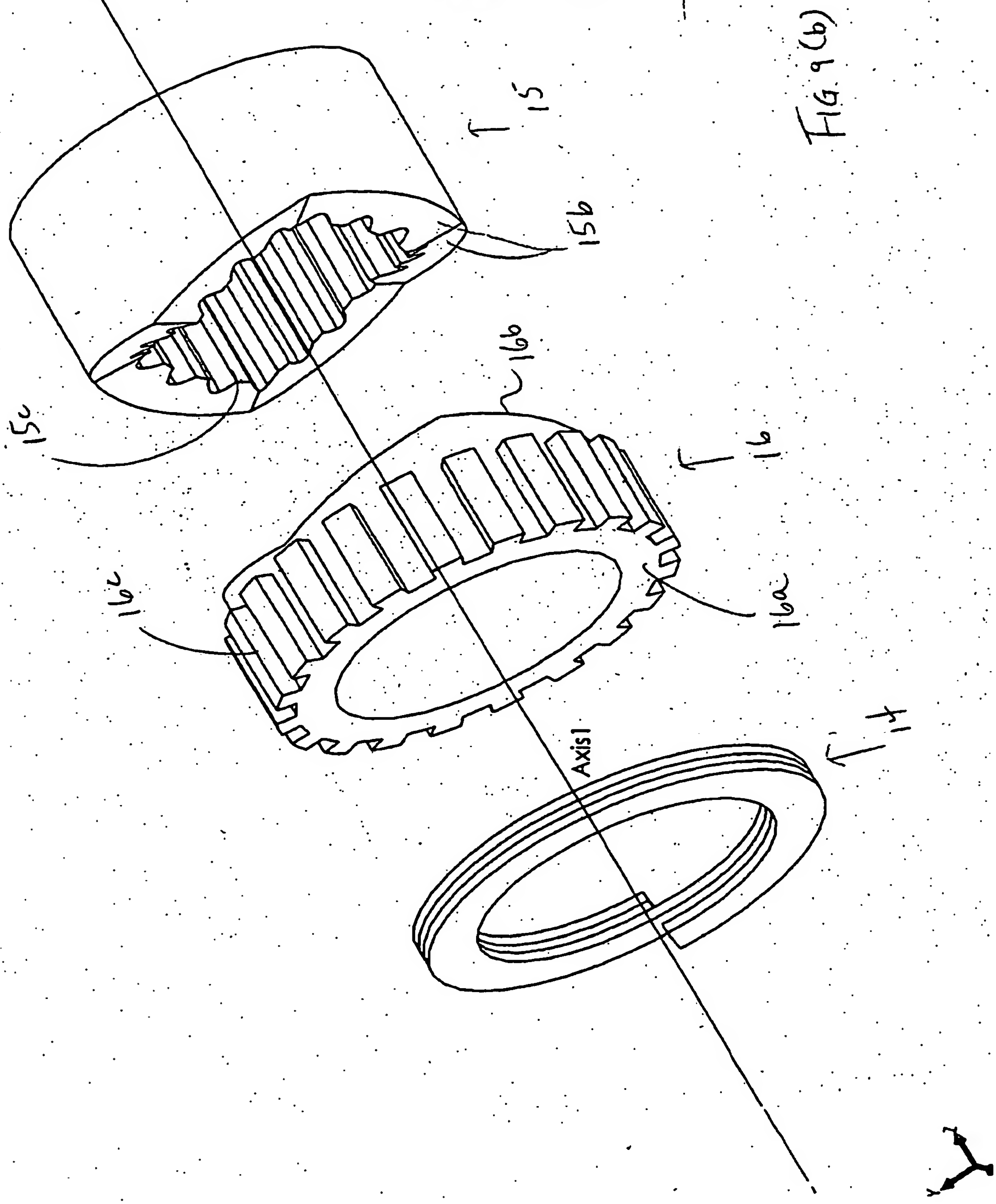

FIG. 9(b)

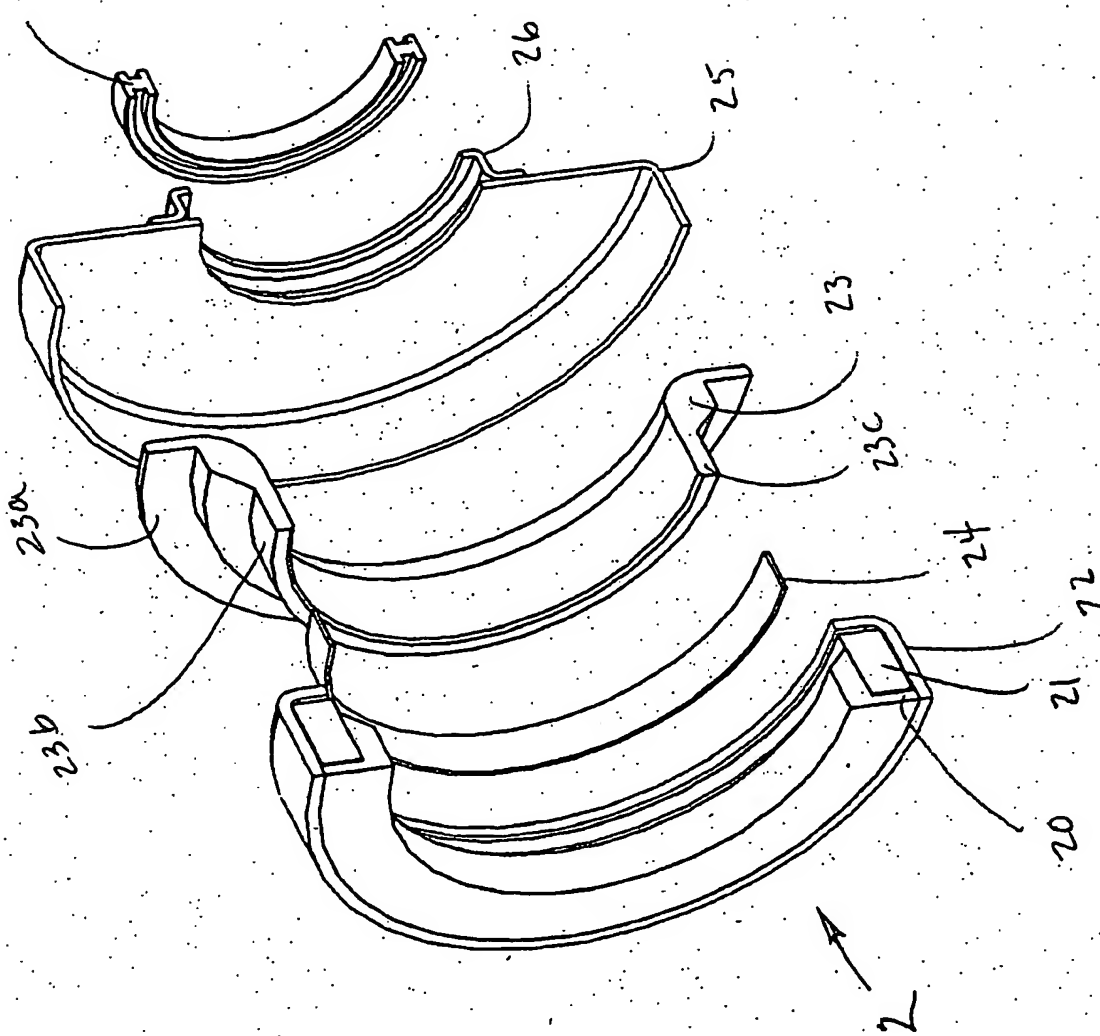

FIG. 10

DN TIMK 8546P2 US Sheet 12 of 13
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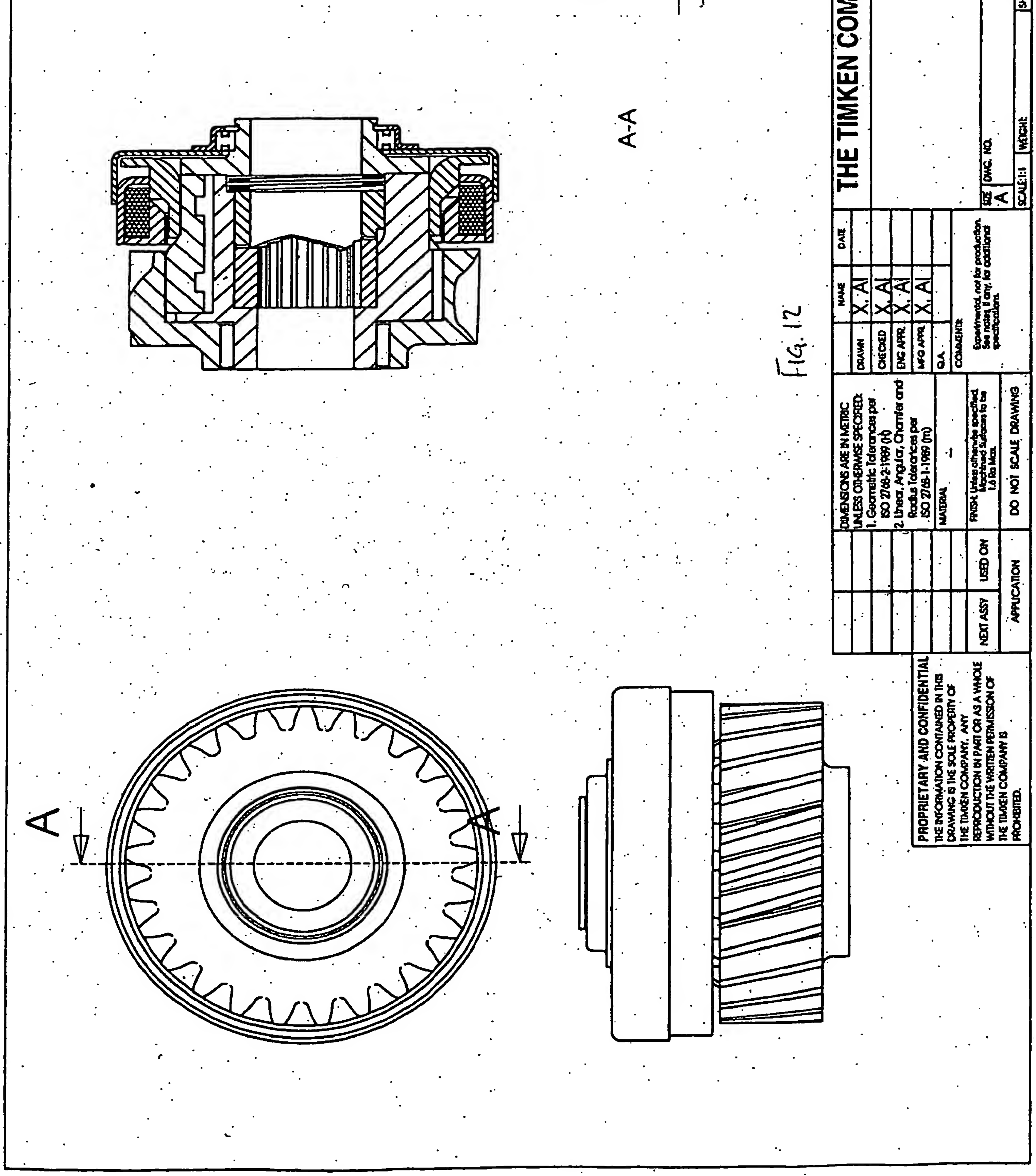

FIG. 12

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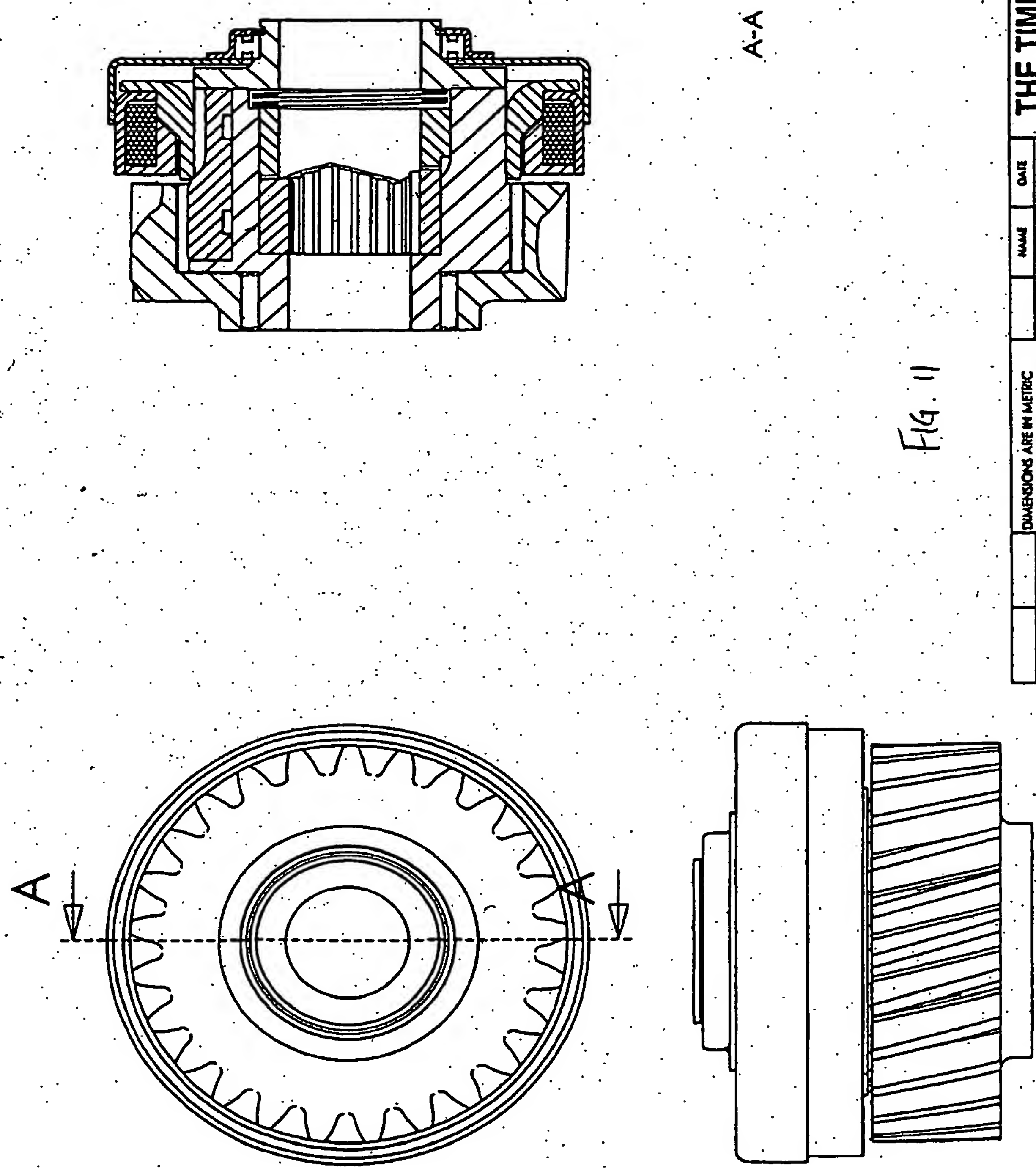

FIG. 11

THE TIMKEN COMPANY

	NAME	DATE
DRAWN	X. Ai	
CHECKED	X. Ai	
ENG APPR.	X. Ai	
MFG APPR.	X. Ai	
Q.A.		

COMMENTS:
Experimental, not for production. See notes, if any, for additional specifications.

SIZE A | DWG. NO. | REV.
SCALE 1:1 | WEIGHT: | SHEET 1 OF 1

DIMENSIONS ARE IN METRIC UNLESS OTHERWISE SPECIFIED:
1. Geometric Tolerances per ISO 2768-2-1989 (H)
2. Linear, Angular, Chamfer and Radius Tolerances per ISO 2768-1-1989 (m)

MATERIAL —

FINISH: Unless otherwise specified, Machined Surfaces to be 1.6 Ra Max.

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NEXT ASSY | USED ON
APPLICATION

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION CONCERNING SUBMISSION OR TRANSMITTAL OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

To:

SMITH, Scott A.
POLSTER LIEDER WOODRUFF & LUCCHESI
12400 Powerscourt Drive
Suite 200
St. Louis, Missouri 63131-3615
ETATS-UNIS D'AMERIQUE

Date of mailing *(day/month/year)* 07 March 2005 (07.03.2005)	
Applicant's or agent's file reference TIMK 8546WO	**IMPORTANT NOTIFICATION**
International application No. PCT/US05/001381	International filing date *(day/month/year)* 14 January 2005 (14.01.2005)
International publication date *(day/month/year)*	Priority date *(day/month/year)* 14 January 2004 (14.01.2004)
Applicant THE TIMKEN COMPANY et al	

1. By means of this Form, which replaces any previously issued notification concerning submission or transmittal of priority documents, the applicant is hereby notified of the date of receipt by the International Bureau of the priority document(s) relating to all earlier application(s) whose priority is claimed. Unless otherwise indicated by the letters "NR", in the right-hand column or by an asterisk appearing next to a date of receipt, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).

2. *(If applicable)* The **letters "NR"** appearing in the right-hand column denote a **priority document which, on the date of mailing of this Form, had not yet been received by the International Bureau** under Rule 17.1(a) or (b). Where, under Rule 17.1(a), the priority document must be submitted by the applicant to the receiving Office or the International Bureau, but the applicant fails to submit the priority document within the applicable time limit under that Rule, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

3. *(If applicable)* **An asterisk (*)** appearing next to a date of receipt, in the right-hand column, denotes **a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b)** (the priority document was received after the time limit prescribed in Rule 17.1(a) or the request to prepare and transmit the priority document was submitted to the receiving Office after the applicable time limit under Rule 17.1(b)). Even though the priority document was not furnished in compliance with Rule 17.1(a) or (b), the International Bureau will nevertheless transmit a copy of the document to the designated Offices, for their consideration. In case such a copy is not accepted by the designated Office as the priority document, Rule 17.1(c) provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

Priority date	Priority application No.	Country or regional Office or PCT receiving Office	Date of receipt of priority document
14 January 2004 (14.01.2004)	60/537,243	US	18 February 2005 (18.02.2005)

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 740 14 35	Authorized officer Villechaise Patrick Facsimile No. +41 22 338 89 70 Telephone No. +41 22 338 8807